

### REMARKS

Claims 1-16, 21-23, 26-28, 30, 32, 34, and 38-49 are pending in this application, with claims 1 and 21 being independent. Claims 1-16, 21-23, 26-28, 30, 32, 34, and 38-49 have been amended, and claims 38-49 have been added.

Claims 1-16, 21-23, 26-28, 30, 32, and 34 were rejected under 35 U.S.C. § 112, second paragraph, as being indefinite. The claims have been carefully reviewed and amended as deemed necessary to ensure that they conform fully to the requirements of Section 112, second paragraph, with special attention to the points raised in paragraph 3 of the Office Action. It is believed that the rejection under Section 112, second paragraph, has been obviated, and its withdrawal is therefore respectfully requested.

Claims 1-7 and 10-15 were rejected under 35 U.S.C. § 102(e) as being anticipated by U.S. Patent Application Publication No. US 2004/0001661 A1 to Iwaki. Claims 16, 21-23, 26, 27, and 34 were rejected under 35 U.S.C. § 103(a) as being obvious from Iwaki; and claims 8, 9, 28, 30, and 32, as being obvious from Iwaki in view of U.S. Patent No. 6,684,007 to Yoshimura.

Applicants submit that independent claims 1 and 21, together with the claims dependent therefrom, are patentably distinct from the cited references for at least the following reasons.

Claim 1 is directed to a printed circuit board element including at least one optical waveguide provided in an optical layer and at least one optoelectronic component in optical connection with the optical waveguide. The optical layer is a single layer of a photoreactive material capable of Two Photon Absorption (TPA) processing. The optoelectronic component is embedded in the optical layer, and the optical waveguide, which is structured by irradiation and a Two Photon Absorption (TPA) process (see, e.g., the paragraph bridging

pages 4 and 5 of the present specification), and which adjoins the optoelectronic component, is present within the optical layer.

The printed circuit board (PCB) element of claim 1 and the method for producing a PCB element of claim 21 have been amended to define still more clearly the present subject matter in which a single, specific optical layer (e.g., designated by reference numeral 3 in the drawings of the present application) is provided, within which the optical waveguide is structured (see, for example, Figures 3 and 4 of the present application and the corresponding description thereof<sup>1</sup>). Accordingly, there is a single (one) layer structure in claims 1 and 21, whereas the prior art, according to Applicant's understanding, always refers to a three-layer structure with a lower cladding layer, a waveguide core layer, and an upper cladding layer.

This is particularly true with respect to Iwaki, cited by the Examiner in paragraph 5 of the Office Action as prior art. Iwaki only discloses a conventional three-layer structure as follows: cladding layer---waveguide core layer---cladding layer. (See, for example, the first element of claim 1 of Iwaka, or paragraphs 0048, 0054, and 0069 of that document.) Therefore, according to this prior art technique, it is necessary to apply at least three optical layers onto a substrate, contrary to the present invention, and, in connection with this specific three-layer structure, a specific different sequence of method steps is provided (see Figs. 7A-7I of Iwaki). It can be rather complicated to achieve an exact mounting of optoelectronic components, for instance, components 101 and 103 of Fig. 7D of Iwaki, in the case that a pre-prepared optical waveguide is already present, since then the mounting of the components must be carried out such that the electro-optical areas of the components are exactly in line

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<sup>1</sup>It is of course to be understood that the references to various portions of the present application are by way of illustration and example only, and that the claims are not limited by the details shown in the portions referred to.

with the pre-prepared optical waveguide.

Contrary to the prior art, according to the present invention there is provided a single, uniform (e.g., 100  $\mu\text{m}$  thick) optical layer. Within this single, uniform optical layer, the intended optical waveguide structure is provided, that is structured by a so-called TPA process, whereby the reflective index of the material of the optical layer is locally changed, namely within the single optical layer; doing so, a so-called gradient index waveguide is obtained, contrary to a step-index waveguide. This TPA-structured optical waveguide is surrounded by the remaining, unchanged optical layer material, and the optical waveguide can have a height or diameter of for example 40  $\mu\text{m}$ ; in view of that, the whole optical layer may have a height of for example 100  $\mu\text{m}$ . Accordingly, it can be very easy to obtain multimode waveguides in the single optical layer, and such multimode waveguides have the advantage that light may be coupled therein very easily and can be guided very well in such a waveguide.

Furthermore, a particular advantage is related to the method as recited in claim 21, namely with the mounting of at least one optoelectronic component before applying the optical layer, and, in particular, before structuring the optical waveguide. In doing so, it is not necessary to have an exact orientation of the optoelectronic components when mounting them, since (as may be seen from present Fig. 4) the position of the optoelectronic component can be measured, whereafter the structuring of the optical waveguide may be controlled accordingly to "adjoin" the respective optoelectronic portions of the components in a very precise manner. Therefore, mounting of all components (i.e., optoelectronic components as well as electric or electronic components) as usual in connection with printed circuit board elements may be performed automatically in the usual manner, and a precise adjoining of the waveguide can be

obtained by precisely controlling the laser beam when structuring the optical waveguide.

Accordingly, claims 1 and 21 are seen to be patentable over Iwaka.

A review of Yoshimura has failed to reveal anything which, in Applicants' opinion, would remedy the deficiencies of the art discussed above, as a reference against the independent claims herein. Yoshimura, et al. only describes structures in which a waveguide core layer is provided between two separate cladding layers, in particular comprised of different materials. Here also, the noted disadvantage with respect to such multilayer optical structure applies.

The other claims in this application are each dependent from one or another of the independent claims discussed above and are therefore believed patentable for the same reasons. Since each dependent claim is also deemed to define an additional aspect of the invention, however, the individual consideration or reconsideration, as the case may be, of the patentability of each on its own merits is respectfully requested.

In view of the foregoing amendments and remarks, Applicants respectfully request favorable reconsideration and early passage to issue of the present application.

Respectfully Submitted



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